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(54) **Improvements in or relating to rotary drill bits.**

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Description

The invention relates to rotauy drill bits for use in drilling or coring deep holes in subsurface formations.

In particular, the invention is applicable to rotary drill bits of the kind comprising a bit body having a shank and an inner channel for supplying drilling fluid to the face of the bit, and where the bit body carries a plurality of so-called "preform" cutting elements. Each cutting element is in the form of a tablet, usually circular, having a hard cutting face formed of polycrystalline diamond or other superhard material.

Conventionally, each cutting element is formed in two layers: a hard facing layer formed of polycrystalline diamond or other superhard material, and a backing layer formed of less hard material, such as cemented tungsten carbide. The two layer arrangement not only permits the use of a thin diamond layer, thus reducing cost, but also provides a degree of self-sharpening since, in use, the less hard backing layer wears away more easily than the harder cutting layer.

In one commonly used method of making rotary drill bits of the above-mentioned type, the bit body is formed by a powder metallurgy process. In this process a hollow mould is first formed, for example from graphite, in the configuration of the bit body or a part thereof. The mould is packed with powdered material, such as tungsten carbide, which is then infiltrated with a metal alloy, such as a copper alloy, in a furnace so as to form a hard matrix.

Where such a method is used to make a drill bit using natural diamond cutting elements, the diamonds are conventionally located on the interior surface of the mould before it is packed with tungsten carbide, so that the diamonds become embedded in the matrix during the formation of the bit body. The maximum furnace temperature required to form the matrix may be of the order of 1050-1170°C, and natural diamonds can withstand such temperatures. Conventional preforms, however, are only thermally stable up to a temperature of 700-750°C. For this reason preform cutting elements are normally mounted on the bit body after it has been moulded, and the interior surface of the mould is suitably shaped to provide surfaces to which the cutting elements may be subsequently hard soldered or brazed, or to provide sockets to receive studs or carriers to which the cutting elements are bonded.

This subsequent mounting of the cutting elements on the body is a time-consuming, difficult and costly process due to the nature of the materials involved, and, due to these difficulties, the mounting of some elements on the bit body is sometimes inadequate, giving rise to rapid fracture or detachment of the elements from the drill bit when in use. Furthermore, the mounting methods which have been developed, although generally effective, sometimes for reasons of space, impose limitations on the positioning of the cutting elements on the bit body.

There are, however, now available polycrystalline diamond materials which are thermally stable up to the infiltration temperature, typically about 1100°C. Such a thermally stable diamond material is supplied by the General Electric Company under the trade name "GEOSET".

This material has been applied to rotary drill bits by setting pieces of the material in the surface of a bit body so as to project partly from the surface, using a similar method to that used for natural diamonds. The pieces have been, for example, in the form of a thick element of triangular shape, one apex of the triangle projecting from the surface of the drill bit and the general plane of the triangle extending either radially or tangentially. However, since such thermally stable elements do not have a backing layer to provide support, they are of substantially greater thickness, in the cutting direction, than conventional preforms in order to provide the necessary strength. This may significantly increase the cost of the cutting elements. Furthermore, the increase in thickness means that the cutting elements are no longer self-sharpening since the portion of the element behind the cutting face does not wear away faster than the cutting face itself, as is the case, as previously mentioned, with two-layer cutting elements.

It is therefore an object of the present invention to provide a rotary drill bit using thermally stable cutting elements, in which the above-mentioned disadvantages of such elements may be overcome. The invention also provides a method of making a rotary drill bit using thermally stable cutting elements.

EP-A-0032428 discloses a rotary drill bit in which non-thermally stable cutting elements, in the form of circular tablets, are mounted on the bit body by being engaged by a separately preformed holding structure, in the form of elongate pegs, which are embedded in the bit body, or in a carrier for the cutting element, and which engage the front face of the cutting element to hold it against a surface of the bit body or carrier. The aim is to reduce bending stresses imparted to the non-thermally stable cutting element in use.

F-A-2388983 discloses the mounting of support elements, for non-thermally stable cutting elements, on a matrix-bodied bit by locating the support elements in the mould when the matrix body is formed. FR-A-1508429 discloses the implanting of natural diamond in matrix-bodied bits by locating the diamonds in the mould in which the matrix body is formed.

According to the present invention there is provided a rotary drill bit including a bit body, at least a portion of which is formed from a matrix formed by a powder metallurgy process, and a plurality of cutting elements mounted on the bit body, each cutting element having a rearward surface in engagement with a support structure on the bit body and a front face, a first portion of the cutting element providing a cutting edge projecting from the bit body, the thickness of the cutting element, between said front and rearward surfaces thereof, being small in relation to the other dimensions of the cutting element, which front surface is engaged by a holding structure on the bit body in front of the cutting element, which extends over a second portion of the cutting element opposite the cutting edge, said holding structure and said support structure being adapted to offer less resistance to forward deflection of said second portion of the cutting element than to rearward deflection of the first portion, thereby to reduce the bending stresses imparted to the cutting element, in use of the bit, by rearward deflection thereof in the vicinity of the cutting edge, characterised in that the cutting elements are formed from material which is thermally stable at the temperature of formation of the matrix, and in that the holding structure comprises an integral extension of the matrix forming the bit body, the lower resistance being provided by the cross-sectional shape of the extension.

The support structure which is adjacent the rearward surface of the cutting element may be provided by an insert in the bit body, the modulus of elasticity of the insert being higher than the modulus of elasticity of the matrix making up the rest of the bit body.

Since the cutting elements of a bit body according to the invention are thermally stable, such a bit body may be manufactured by a method which incorporates the elements in the bit body during the formation of the bit body, rather than mounting the elements on the bit body after it has been formed, as has been the case hitherto with preform cutting elements.

Accordingly, the invention also provides a method of manufacturing by a powder metallurgy process a rotary drill bit including a bit body having a plurality of cutting elements mounted on the outer surface thereof, the method being of the kind comprising the steps of forming a hollow mould for moulding at least a portion of the bit body, packing the mould with powdered matrix material, and infiltrating the material with a metal alloy in a furnace to form a matrix, characterised in that the method further comprises the steps, before packing the mould with powdered matrix material, of:

a. positioning in spaced locations on the interior surface of the mould a plurality of cutting elements, each of which is formed of a material which is thermally stable at the temperature necessary to form the matrix, and

b. providing adjacent the front side of each cutting element a recess in the surface of the mould extending across part of the frontward surface of each cutting element, when said element is in position in the mould, which recess receives powdered matrix material when the mould is packed and thereby, when the matrix is formed, provides a holding portion integral with the matrix body and engaging the front face of the cutting element to hold it in position on the bit body, the configuration of the holding portion, as defined by said recess in the mould, being such that the resistance provided by the holding portion to forward deflection of the portion of the cutting element opposite the cutting edge is less than the resistance to rearward deflection provided by material supporting the rearward surface of the cutting element adjacent the cutting edge thereof, thereby to reduce bending stresses imparted to the cutting element by rearward deflection thereof in the vicinity of the cutting edge.

The material to fill said recess in the mould to form an integral extension of the matrix to act as a holding structure may be applied to the mould in the form of a material, such as a powdered matrix material, which is converted to a hard material of lower modulus of elasticity than the rest of the matrix as a result of the process for forming the matrix. For example, the powdered matrix material from which the matrix is formed may be applied to the mould as a compound, known as "wet mix", comprising the powdered material mixed with a liquid to form a paste. The liquid may be a hydrocarbon such as polyethylene glycol. Accordingly, the material for application to the recess to form the holding structure may be applied in the form of a body of "wet mix" applied to the recess adjacent the front side of the cutting element before the rest of the mould is packed, the characteristics of the initial body of "wet mix" being such that the resulting matrix has a lower modulus of elasticity than the matrix forming the rest of the bit body. The characteristics of the wet mix may be varied, for example by varying the powder grain size distribution to vary the skeletal density and thus adjust the hardness of the resulting matrix.

Other methods of varying the hardness of the matrix in the wet mix may be employed, for example the addition to the wet mix of a powder, such as tungsten metal, nickel or iron powder, which will result in a matrix of lower modulus of elasticity. Instead of, or in addition to, reducing the hardness of the holding structure, the hardness of the support structure adjacent the rearward surface of each cutting element may be increased, for example by using at that location a body of wet mix of suitable characteristics. Thus, the normal matrix from which the bit body is formed may include nickel, and the hardness of the bit body adjacent the rearward side of each cutting element may be increased by placing at that location, in the mould, a body of wet mix in which the proportion of nickel is reduced.

In any of the above arrangements each cutting element may be formed of polycrystalline diamond material and may be in the form of a tablet, such as a circular disc, of such material, the opposite major faces of the tablet constituting said front and rearward faces thereof respectively.

The following is a more detailed description of various embodiments of the invention, reference being made to the accompanying drawings, in which:

Figure 1 is a side elevation of a typical drill bit of a kind to which the invention is particularly applicable,

Figure 2 is an end elevation of the drill bit shown in Figure 1,

Figure 3 is a diagrammatic section through a cutting element of a rotary drill bit illustrating the construction and method of manufacture according to the invention.

Figures 4 and 5 are similar views through alternative mountings of cutting elements according to the invention, and

Figure 6 is a front elevation of the cutting element shown in Figure 5.

Referring to Figures 1 and 2, the rotary drill bit comprises a bit body 10 which is typically formed of tungsten carbide matrix infiltrated with a binder alloy, usually a copper alloy. There is provided a steel threaded shank 11 at one end of the bit body for connection to the drill string.

The operative end face 12 of the bit body is formed with a number of blades 13 radiating from the central area of the bit and the blades carry cutting elements 14 spaced apart along the length thereof.

The bit has a gauge section 15 including kickers 16 which contact the walls of the borehole to stabilise the bit in the borehole. A central channel (not shown) in the bit body and shank delivers drilling fluid through nozzles 17 in the end face 12 in known manner.

It will be appreciated that this is only one example of the many possible variations of the type of bit to which the invention is applicable.

The techniques of forming such bit bodies by powder metallurgy moulding processes are well known, as previously mentioned, and there will now be described modifications of the known methods by which thermally stable cutting elements are mounted on the bit body in the course of the moulding process, instead of the cutting elements being mounted on the bit body after moulding, as has previously been the case with preforms.

Referring to Figure 3, a mould 18 is formed from graphite and has an internal configuration corresponding generally to the required surface shape of the bit body or a portion thereof. That is to say the mould 18 is formed with elongate recesses 19 corresponding to the blades 17. Spaced apart along each recess 19 are a plurality of part-circular recesses 20 each corresponding to the required location of a cutting element. A further recess 21 is provided in the surface of the mould 18 adjacent each recess 20.

Following construction of the mould, a plurality of circular disc-shaped thermally stable cutting elements 14 are secured within the recesses 20, as shown in Figure 3, by means of suitable adhesive.

As previously mentioned, the mould may be packed with powdered matrix material in the form of a compound, known as "wet mix", comprising tungsten carbide powder mixed with polyethylene glycol. Once the mould has been packed it is heated in a furnace to burn off the polyethylene glycol whereafter the material is infiltrated with copper alloy to form the matrix.

In accordance with the present invention, however, before the mould is packed with wet mix in the normal way, the recess 21 adjacent the front side of each cutting element 14 is partly filled with a body of wet mix, indicated at 22, the composition of which is such that the resulting matrix has a lower modulus of elasticity than the matrix 23 forming the main part of the bit body. The body of wet mix 22 extends around the radially inner edge of the cutting element 14, opposite its cutting edge 25.

The body of matrix formed in the recess 21 provides, in the finished body, a holding structure which holds the cutting element 14 to the bit body. The extremity of the holding structure will, in use, wear down at least as rapidly as the cutting element 14 and blade 19, as drilling proceeds, the erosion being due largely to the flow of drilling mud and debris over the holding portion. This ensures that an adequate area of the front cutting face of the cutting element 14 remains exposed as the cutting element becomes worn.

Loads imparted to the cutting element 14 during drilling put compressive stress on the matrix to the rear of the cutting element 14, particularly in the vicinity of the cutting edge 25. Yielding of this matrix material under such stress will impose bending stresses on the cutting element if the cutting element is rigidly held. However, according to the invention, the matrix 24 adjacent the front face of the cutting element in the vicinity thereof opposite the cutting edge 25 is of lower modulus of elasticity than the matrix forming the main part of the bit body so that it provides less resistance to deflection of the cutting element than does the matrix forming the bit body. Consequently the cutting element may in effect tilt bodily when under load rather than being subject to high bending stresses. There is thus less tendency for the cutting element to fracture and it may therefore be of lesser thickness than would otherwise be the case, not only reducing the cost of the cutting element, but also providing a degree of self-sharpening. Some compositions of "wet mix" may provide a matrix having both sufficiently low erosion resistance and sufficiently low modulus of elasticity. In this case the recess 21 may be filled with a single body of such wet mix instead of with two different compositions.

In the alternative arrangement shown in Figure 4 the lower resistance to deflection of the cutting element 14 provided by the holding structure is provided by forming within the matrix an aperture 26 into which the edge of the cutting element projects so that the integral extension 27 of the matrix which forms the holding element engages only the central portion of the cutting element. The aperture 26 may be formed by initially enclosing the edge portion of the cutting element in a material which burns off as the matrix is formed. Preferably, the material may be retained in the finished bit body and in this case is a material of lower modulus of elasticity than the matrix. The integral extension 27 of the matrix may be of the same composition as the main body of matrix or may be formed from a different wet mix so as to be of lower modulus of elasticity.

In the arrangements of Figures 5 and 6 the cutting element 14 is preformed with a hole 28 which fills with matrix and thus positively holds the cutting element to the bit body. A similar holding effect may be obtained by the element being formed with one or more recesses which fill with matrix.

Although the cutting elements have been described above as being circular discs or tablets, other forms of cutting element are, of course, possible.

The purpose of the described holding arrangements for the cutting element 14 is, as previously mentioned, to reduce the risk of fracture of the cutting elements due to bending stresses imparted to them during drilling as a result of yielding of the material on the rearward side of the cutting elements. Although the risk of fracture is thus reduced by the arrangements described, a further improvement may be obtained by inserting on the rearward side of each cutting element a support of a higher modulus of elasticity than the matrix and such a support is indicated in dotted lines at 32 in Figure 3. The insert 32 may also be incorporated in the bit body in the course of the moulding process, and may comprise a rigid preformed insert or a body of wet mix of such composition to give a matrix of high modulus of elasticity.

Although the invention has been described in relation to single layer cutting elements of polycrystalline diamond, this is merely because this is the only type of thermally stable preform cutting element which is currently available. The present invention relates to methods of holding the preform in the bit body rather than to the particular material of the preform, and thus includes within its scope drill bits and methods of the kinds referred to when used with other types of thermally stable cutting elements which may be developed, including two layer or multi-layer preforms and those where the superhard material is material other than polycrystalline diamond.

Claims

1. A rotary drill bit including a bit body, at least a portion of which is formed from a matrix formed by a powder metallurgy process, and a plurality of cutting elements (14) mounted on the bit body, each cutting element having a rearward surface in engagement with a support structure (13) on the bit body and a front face, a first portion of the cutting element providing a cutting edge (25) projecting from the bit body, the thickness of the cutting element, between said front and rearward surfaces thereof, being small in relation to the other dimensions of the cutting element, which front surface is engaged by a holding structure on the bit body in front of the cutting element, which extends over a second portion of the cutting element opposite the cutting edge, said holding structure and said support structure being adapted to offer less resistance to forward deflection of said second portion of the cutting element than to rearward deflection of the first portion, thereby to reduce the bending stresses imparted to the cutting element, in use of the bit, by rearward deflection thereof in the vicinity of the cutting edge, characterised in that the cutting elements (14) are formed from material which is thermally stable at the temperature of formation of the matrix, and in that the holding structure (22, 27) comprises an integral extension of the matrix forming the bit body, the lower resistance being provided by the cross-sectional shape of the extension.

2. A rotary drill bit according to Claim 1, wherein said integral extension (22, 27) of the matrix which engages said second portion of the cutting element is thinner, in the forward and rearward direction, than the support structure (13) on the bit body which is engaged by the rearward surface of the cutting element, thereby providing the lower resistance to deflection offered by said integral extension of the matrix.

3. A rotary drill bit according to Claim 1 or Claim 2, wherein the extension (27) is formed with an aperture or recess (26) adjacent the front surface of said second portion of the cutting element (14).

4. A rotary drill bit according to any of Claims 1 to 3, wherein an aperture or recess (26) is provided in the matrix adjacent the rearward surface of the second portion of the cutting element (14).

5. A rotary drill bit according to any of Claims 1 to 4, wherein said integral extension (22, 27) of the matrix is formed from matrix of a lower modulus of elasticity than the material forming said support structure for the cutting element.

6. A rotary drill bit according to any of Claims 1 to 5, wherein the support structure adjacent the rearward surface of the cutting element is provided by an insert (32) in the bit body, the modulus of elasticity of the insert being higher than the modulus of elasticity of the matrix making up the rest of the bit body.

7. A rotary drill bit according to any of Claims 1 to 6, wherein each cutting element (14) is formed of polycrystalline diamond material and is in the form of a tablet of such material, the opposite major faces of the tablet constituting said front and rearward faces thereof respectively.

8. A rotary drill bit according to Claim 7, wherein each cutting element (14) is in the form of a circular disc.

9. A method of manufacturing by a powder metallurgy process a rotary drill bit including a bit body having a plurality of cutting elements mounted on the outer surface thereof, the method being of the kind comprising the steps of forming a hollow mould for moulding at least a portion of the bit body, packing the mould with powdered matrix material, and infiltrating the material with a metal alloy in a furnace to form a matrix, characterised in that the method further comprises the steps, before packing the mould with powdered matrix material, of:

a. positioning in spaced locations on the interior surface of the mould a plurality of cutting elements (14), each of which is formed of a material which is thermally stable at the temperature necessary to form the matrix, and

b. providing adjacent the front side of each cutting element a recess (21) in the surface of the mould (18) extending across part of the frontward surface of each cutting element (14), when said element is in position in the mould, which recess receives powdered matrix material when the mould is packed and thereby, when the matrix is formed, provides a holding portion integral with the matrix body and engaging the front face of the cutting element to hold it in position on the bit body, the configuration of the holding portion, as defined by said recess (21) in the mould, being such that the resistance provided by the holding portion to forward deflection of the portion of the cutting element opposite the cutting edge is less than the resistance to rearward deflection provided by material supporting the rearward surface of the cutting element adjacent the cutting edge thereof, thereby to reduce bending stresses imparted to the cutting element by rearward deflection thereof in the vicinity of the cutting edge.

10. A method according to Claim 9, characterised in that the material (22) to fill said recess in the mould to form an integral extension of the matrix to act as a holding structure is applied to the mould in the form of a material which is converted to a hard material of lower modulus of elasticity than the rest of the matrix as a result of the process for forming the matrix.

11. A method according to Claim 10, characterised in that the material (22) to fill said recess in the mould is a powdered matrix material.

12. A method according to Claim 11, characterised in that said powdered matrix material is applied to the mould as a compound comprising the powdered material mixed with a liquid to form a paste.

13. A method according to Claim 12, characterised in that the liquid is a hydrocarbon.

14. A method according to Claim 13, characterised in that the hydrocarbon is polyethylene glycol.

Patentansprüche

1. Drehbohrmeißel mit einem Meißelkörper, von dem wenigstens ein Teil aus einer Matrix besteht, die durch ein Pulvermetallurgieverfahren hergestellt worden ist, und mit mehreren Schneidelementen (14), die an dem Meißelkörper befestigt sind, wobei jedes Schneidelement eine Rückfläche in Berührung mit einer Tragvorrichtung (13) an dem Meißelkörper und eine Frontfläche hat, wobei ein erster Teil des Schneidelements eine Schneidkante (25) bildet, die von dem Meißelkörper vorsteht, wobei die Dicke des Schneidelements zwischen der Front- und der Rückfläche desselben im Verhältnis zu den anderen Abmessungen des Schneidelements klein ist, wobei die Frontfläche durch eine Haltevorrichtung an dem Meißelkörper vor dem Schneidelement erfaßt wird, die sich über einen zweiten Teil des Schneidelements erstreckt, der zu der Schneidkante entgegengesetzt ist, wobei die Haltevorrichtung und die Tragvorrichtung so ausgebildet sind, daß sie dem Vorwärtsbiegen des zweiten Teils des Schneidelements weniger Widerstand entgegensetzen als dem Rückwärtsbiegen des ersten Teils, um dadurch die Biegebeanspruchungen zu reduzieren, die auf das Schneidelement im Gebrauch des Meißels durch Rückwärtsbiegen desselben in der Nähe der Schneidkante ausgeübt werden, dadurch gekennzeichnet, daß die Schneidelemente (14) aus einem Material gebildet sind, das bei der Temperatur der Bildung der Matrix thermisch stabil ist, und daß die Haltevorrichtung (22, 27) einen angeformten Fortsatz der Matrix aufweist, die den Meißelkörper bildet, wobei der geringere Widerstand durch die Querschnittsform des Fortsatzes erzielt wird.

2. Drehbohrmeißel nach Anspruch 1, wobei der angeformte Fortsatz (22, 27) der Matrix, der den zweiten Teil des Schneidelements erfaßt, in der Vorwärts- und in der Rückwärtsrichtung dünner ist als die Tragvorrichtung (13) an dem Meißelkörper, die durch die Rückfläche des Schneidelements erfaßt wird, wodurch der geringere Widerstand gegen Biegen geschaffen wird, den der angeformte Fortsatz der Matrix bildet.

3. Drehbohrmeißel nach Anspruch 1 oder 2, wobei der Fortsatz (27) mit einem Loch oder einer Aussparung (26) an der Frontfläche des zweiten Teils des Schneidelements (14) versehen ist.

4. Drehbohrmeißel nach einem der Ansprüche 1 bis 3, wobei ein Loch oder eine Aussparung (26) in der Matrix an der Rückfläche des zweiten Teils des Schneidelements (14) vorgesehen ist.

5. Drehbohrmeißel nach einem der Ansprüche 1 bis 4, wobei der angeformte Fortsatz (22, 27) der Matrix aus Material mit einem niedrigeren Elastizitätsmodul als das die Tragvorrichtung für das Schneidelement bildende Material gebildet ist.

6. Drehbohrmeißel nach einem der Ansprüche 1 bis 5, wobei die Tragvorrichtung an der Rückfläche des Schneidelements durch einen Einsatz (32) in dem Meißelkörper gebildet ist, wobei der Elastizitätsmodul des Einsatzes höher ist als der Elastizitätsmodul der Matrix, aus der der Rest des Meißelkörpers besteht.

7. Drehbohrmeißel nach einem der Ansprüche 1 bis 6, wobei jedes Schneidelement (14) aus polykristallinem Diamantmaterial gebildet ist und die Form einer Tablette aus diesem Material hat, wobei die entgegengesetzten Hauptflächen der Tablette deren Front bzw. Rückfläche bilden.

8. Drehbohrmeißel nach Anspruch 7, wobei jedes Schneidelement (14) die Form einer Kreisscheibe hat.

9. Verfahren zum Herstellen eines Drehbohrmeißels durch ein Pulvermetallurgieverfahren, mit einem Meißelkörper, der mehrere Schneidelemente hat, die an der äußeren Oberfläche desselben befestigt sind, wobei das Verfahren die Schritte beinhaltet, eine hohle Form zum Formen wenigstens eines Teils des Meißelkörpers herzustellen, die Form mit pulverförmigem Matrixmaterial zu füllen und das Material mit einer Metalle-

gierung in einem Ofen zu infiltrieren, um eine Matrix herzustellen, dadurch gekennzeichnet, daß das Verfahren weiter die Schritte beinhaltet, vor dem Füllen der Form mit pulverförmigem Matrixmaterial:

a) an gegenseitigen Abstand aufweisenden Stellen an der Innenoberfläche der Form mehrere Schneidelemente (14) zu positionieren, von denen jedes aus einem Material besteht, das bei der Temperatur, die zum Bilden der Matrix notwendig ist, thermisch stabil ist, und

b) an der Frontseite jedes Schneidelements eine Aussparung (21) in der Oberfläche der Form (18) vorzusehen, die sich über einen Teil der vorderen Fläche jedes Schneidelements (14) erstreckt, wenn das Element in der Form in Position ist, wobei die Aussparung pulverförmiges Matrixmaterial aufnimmt, wenn die Form gefüllt wird, und dadurch, wenn die Matrix gebildet wird, einen Halteteil bildet, der einstückig mit dem Matrixkörper ist und die Frontfläche des Schneidelements berührt, um es in seiner Position an dem Meißelkörper festzuhalten, wobei die Konfiguration des Halteteils, wie sie durch die Aussparung (21) in der Form festgelegt wird, so ist, daß der Widerstand, den der Halteteil einem Vorwärtsbiegen des Teils des Schneidelements entgegensetzt, der zu der Schneidkante entgegengesetzt ist, kleiner ist als der Widerstand gegen Rückwärtsbiegen, den das Material, welches die Rückfläche des Schneidelements an dessen Schneidkante abstützt, entgegensetzt, wodurch Biegebeanspruchungen reduziert werden, welche auf das Schneidelement durch Rückwärtsbiegen desselben in der Nähe der Schneidkante ausgeübt werden.

10. Verfahren nach Anspruch 9, dadurch gekennzeichnet, daß das Material (22) zum Füllen der Aussparung in der Form, um einen angeformten Fortsatz der Matrix herzustellen, der als Haltevorrichtung dient, in die Form als ein Material eingebracht wird, welches in ein hartes Material mit niedrigerem Elastizitätsmodul als der Rest der Matrix als Ergebnis des Verfahrens zum Herstellen der Matrix umgewandelt wird.

11. Verfahren nach Anspruch 10, dadurch gekennzeichnet, daß das Material (22) zum Füllen der Aussparung in der Form ein Pulverförmiges Matrixmaterial ist.

12. Verfahren nach Anspruch 11, dadurch gekennzeichnet, daß das pulverförmige Matrixmaterial in die Form als eine Masse eingebracht wird, die aus dem pulverförmigen Material besteht, das mit einer Flüssigkeit zum Bilden einer Paste vermischt ist.

13. Verfahren nach Anspruch 12, dadurch gekennzeichnet, daß die Flüssigkeit ein Kohlenwasserstoff ist.

14. Verfahren nach Anspruch 13, dadurch gekennzeichnet, daß der Kohlenwasserstoff polyethylenglycol ist.

Revendications

1. Trépan de forage rotary, comprenant un corps de trépan, dont au moins une partie est formée d'une matrice réalisée par un procédé de métallurgie des poudres, et de nombreux éléments de coupe (14) montés sur ce corps de trépan, chaque élément de coupe possédant une surface arrière qui se trouve au contact d'une structure de support (13) située sur le corps de trépan et une surface avant, une première partie de l'élément de coupe offrant une arête de coupe (25) qui fait saillie par rapport au corps de trépan et l'épaisseur de l'élément de coupe, entre ses surfaces avant et arrière, étant faible par rapport aux autres dimensions de l'élément de coupe, tandis que se trouve au contact de la surface avant une structure de retenue qui est située sur le corps de trépan en avant de l'élément de coupe et qui s'étend au-dessus d'une seconde partie de cet élément de coupe située à l'opposé de l'arête de coupe, cette structure de retenue et la structure de support étant agencées de façon à offrir moins de résistance à un fléchissement vers l'avant de la seconde partie de l'élément de coupe qu'à un fléchissement vers l'arrière de la première partie, de manière à réduire ainsi les contraintes de flexion qui s'exercent sur l'élément de coupe, au cours de l'utilisation du trépan, du fait d'un fléchissement de celui-ci vers l'arrière au voisinage de l'arête de coupe, caractérisé en ce que les éléments de coupe (14) so réalisés en un matériau qui est thermiquement stable à la température de formation de la matrice et en ce que la structure de retenue (22, 27) est constituée par un prolongement, venu de matière, de la matrice formant le corps de trépan, la résistance plus faible étant assurée par la forme du prolongement en coupe transversale.

2. Trépan de forage rotary suivant la revendication 1, dans lequel le prolongement venu de matière (22, 27) de la matrice qui se trouve au contact de la seconde partie de l'élément de coupe est plus mince, dans le direction vers l'avant et vers l'arrière, que la structure de support (13) située sur le corps de trépan et au contact de laquelle se trouve la surface arrière de l'élément de coupe, ce qui assure ainsi la résistance inférieure au fléchissement offerte par ce prolongement venu de matière de la matrice.

3. Trépan de forage rotary suivant la revendication 1 ou la revendication 2, dans lequel il est ménagé dans le prolongement (27) une ouverture ou évidement (26) qui est adjacent à la surface avant de la seconde partie de l'élément de coupe (14).

4. Trépan de forage rotary suivant l'une quelconque des revendications 1 à 3, dans lequel une ouverture ou évidement (26) est ménagé dans la matrice en un emplacement adjacent à la surface arrière de la seconde partie de l'élément de coupe (14).

5. Trépan de forage rotary suivant l'une quelconque des revendications 1 à 4, dans lequel le prolongement venu de matière (22, 27) de la matrice est formé d'une matrice à module d'élasticité plus faible que le matériau formant la structure de support prévue pour l'élément de coupe.

6. Trépan de forage rotary suivant l'une quelconque des revendications 1 à 5, dans lequel la

structure de support située en un emplacement adjacent à la surface arrière de l'élément de coupe est fournie par un élément rapporté (32) disposé dans le corps de trépan, le module d'élasticité de cet élément rapporté étant supérieur au module d'élasticité de la matrice constituant le reste du corps de trépan.

7. Trépan de forage rotary suivant l'une quelconque des revendications 1 à 6, dans lequel chaque élément de coupe (14) est réalisé en un matériau formé de diamant polycristallin et se présente sous la forme d'une pastille d'un tel matériau, les faces principales opposées de cette pastille constituant respectivement les surfaces avant et arrière de l'élément.

8. Trépan de forage rotary suivant la revendication 7, dans lequel chaque élément de coupe (14) se présente sous la forme d'un disque circulaire.

9. Procédé de fabrication, par un procédé de métallurgie des poudres, d'un trépan de forage rotary comprenant un corps de trépan comportant de nombreux éléments de coupe montés sur sa surface extérieure, ce procédé étant du type consistant à former un moule creux permettant de mouler au moins une partie du corps de trépan, à remplir ce moule avec un matériau en poudre pour matrice et à faire s'infiltrer un alliage métallique dans ce matériau, dans un four, de façon à former une matrice, caractérisé en ce que ce procédé consiste en outre, avant de remplir le moule avec le matériau en poudre pour matrice:

a) à mettre en place, en des emplacements espacés sur la surface intérieure du moule, de nombreux éléments de coupe (14) dont chacun est formé d'un matériau qui est thermiquement stable à la température nécessaire pour former la matrice et

b) à ménager, dans une position adjacente à la surface avant de chaque élément de coupe et dans la surface du moule (18), un évidement (21) s'étendant en travers d'une partie de la surface avant de chaque élément de coupe (14) lorsque cet élément est en position dans le moule, cet évidement recevant du matériau en poudre pour matrice lorsqu'on remplit le moule et réalisant ainsi, lorsqu'on forme la matrice, une partie de retenue venue de matière avec la masse de la matrice et se trouvant au contact de la surface avant de l'élément de coupe afin de le maintenir en position sur le corps de trépan, la forme de cette partie de retenue, telle que définie par l'évidement (21) ménagé dans le moule, étant telle que la résistance fournie par cette partie de retenue à un fléchissement vers l'avant de la partie de l'élément de coupe qui est située à l'opposé de l'arête de coupe soit inférieure à la résistance à un fléchissement vers l'arrière qui est fournie par le matériau supportant la surface arrière de l'élément de coupe en un emplacement adjacent à l'arête de coupe de celui-ci, de façon à réduire ainsi les contraintes de flexion s'exerçant sur l'élément de coupe du fait d'un fléchissement de celui-ci vers l'arrière au voisinage de l'arête de coupe.

10. Procédé suivant la revendication 9, caractérisé en ce que le matériau (22) destiné à remplir l'évidement ménagé dans le moule, afin de former un prolongement venu de matière de la matrice en vue de servir de partie de retenue, est appliqué dans le moule sous la forme d'un matériau qui est converti en un matériau dur de module d'élasticité plus faible que le reste de la matrice, ce qui résulte du procédé de réalisation de la matrice.

11. Procédé suivant la revendication 10, caractérisé en ce que le matériau (22) destiné à remplir l'évidement ménagé dans le moule est un matériau en poudre pour matrice.

12. Procédé suivant la revendication 11, caractérisé en ce que le matériau en poudre pour matrice est appliqué dans le moule sous forme d'un composé comprenant le matériau en poudre mélangé avec un liquide de façon à former une pâte.

13. Procédé suivant la revendication 12, caractérisé en ce que le liquide est un hydrocarbure.

14. Procédé suivant la revendication 13, caractérisé en ce que l'hydrocarbure est le polyéthylèneglycol.

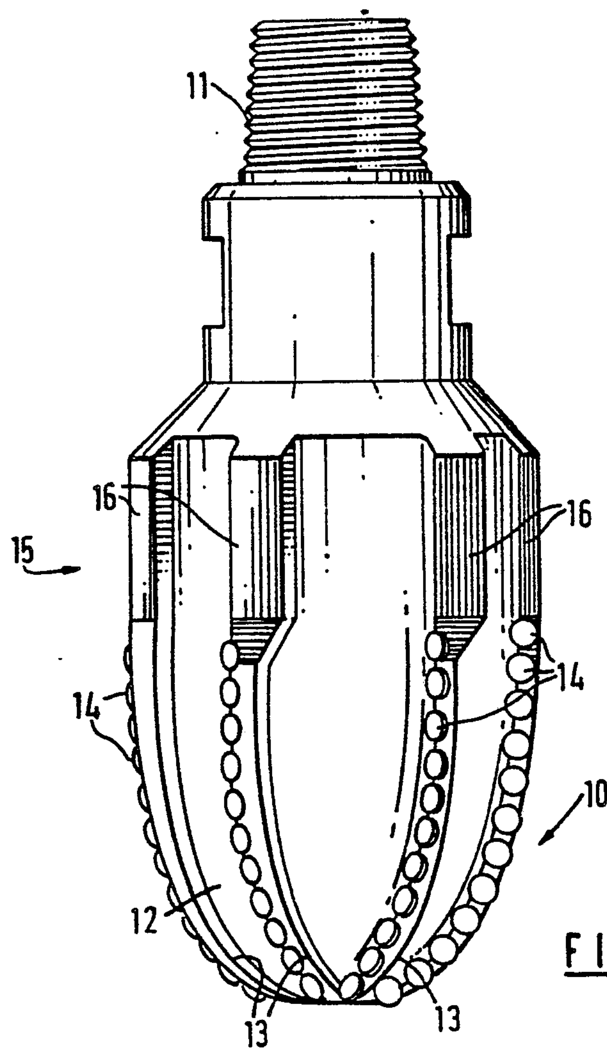

FIG.1

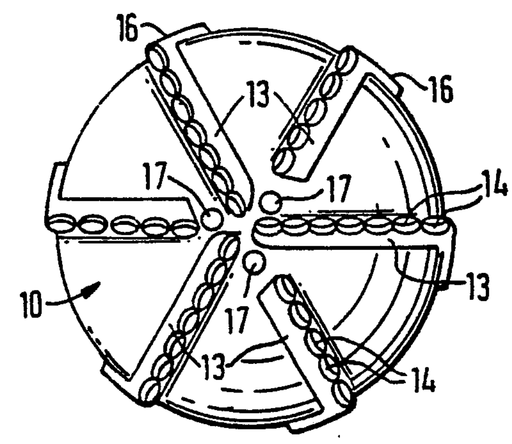

FIG.2

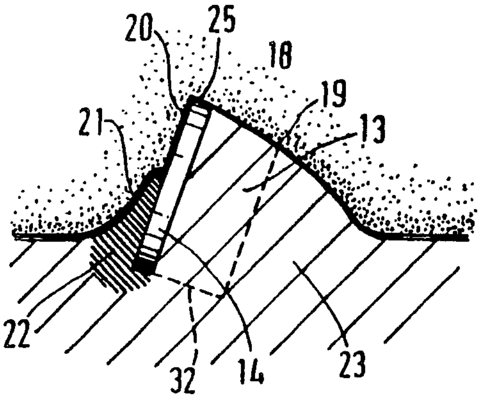

FIG.3

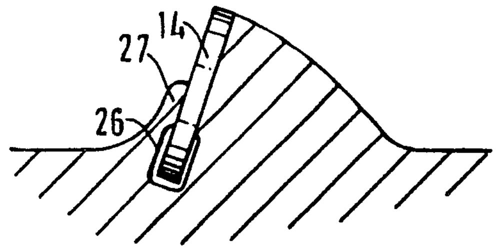

FIG.4

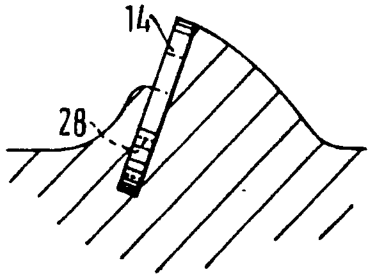

FIG.5

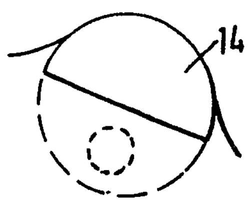

FIG.6